SERVICE MANUAL

MODEL PLUS 4 COMPUTER

OCT. 1984 PN-314001-04

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PLUS 4 PRODUCT SPECIFICATION

MEMORY

64K RAM. 60K RAM User accessible for BASIC programs.

ROM

32K ROM Standard (includes operating system and BASIC interpreter) with 32K additional ROM containing the built-in productivity software.

MICROPROCESSOR

7501 Microprocessor — .89 or 1.76 MHz clock.

DISPLAY

40 Columns x 25 lines of text.

COLORS

128 Colors (16 colors; 8 luminance levels).

CHARACTERS

Upper & lower case letters, numerals and symbols. Reverse and flashing charachters. All PET graphic characters.

DISPLAY MODES

Text characters. High resolution graphics. Split screen text/high resolution graphics. Multicolor graphics.

RESOLUTION

320 x 200 Pixels

SOUND

2 Tone generators or 1 Tone and 1 white noise generator.

VOLUME

8 Volume levels

KEYBOARD

Full size typewriter style design

KEYS

67 Keys total. 4 Cursor control keys. 4 Programmed (reprogrammable) function keys (up to 8 user defined functions possible). Color control keys. HELP key. Upper and lower case character set. Graphics character set.

INPUTS/OUTPUTS

PLUS/4 MODEM (User) port. Serial port. ROM cartridge and parallel disk drive port. 2 Joystick ports. C1531 Cassette drive interface port. RF Output-channel 3 or 4. Video output-composite/ chrominance/luminance. Audio input/output. Power supply input.

PLUS 4 PRODUCT SPECIFICATION (Continued)

FEATURES

Built-in extended BASIC 3.5 — over 75 commands. Built-in Machine Language monitor — over 12 commands. Built-in graphics and sound commands. Screen window capability. Reset button (Warm start). Built-in integrated productivity software.

PERIPHERALS

C1551 Fast Disk drive, C1531 Datasette, MPS 802 Dot matrix printer, MPS 803 Dot matrix printer, DPS 1101 Daisy wheel printer, C1802 color monitor.

OTHER PERIPHERALS

C1541 Disk drive, MPS 801 Dot matrix printer, C1702 color monitor.

PLUS 4 OVERVIEW

The Plus 4 system is based on the 7501 microprocessor, an HMOS version of the 6510. Video processing is achieved by the 7360 TED chip. 64K bytes of dynamic RAM are accomplished by 8 (64K x 1) I.C.'s. (See page). The system program is contained in 2 (16K x 8) ROMs. The system supports up to 128K x 8 of ROM banked in 16K sections. By software control, through the 7360, ROM can be completely banked out and RAM banked in for a true 64K of RAM (minus 256 byte pages), allowing 60,671 bytes available for BASIC.

Keyboard and joystick scanning are accomplished by outputting the row data on the data bus while addressing a particular register in the TED chip. This will in turn cause the TED chip to latch the column information.

A standard serial port supports serial bus peripherals such as the 1541 disk drive and the various serial printers. A cassette port is provided and the expansion port supports ROM cartrdiges. TTL serial ASCII is intended to drive an RS-232 adapter.

PARTS LIST
PLUS/4

TOP CASE ASSY

Top Case	C 251453-01
Keyboard, 67 Key, KKR-I	C 251501-01
Nameplate	C 251655-01
Shield Clip, R	C 251855-01
Shield Clip, F	C 251856-01

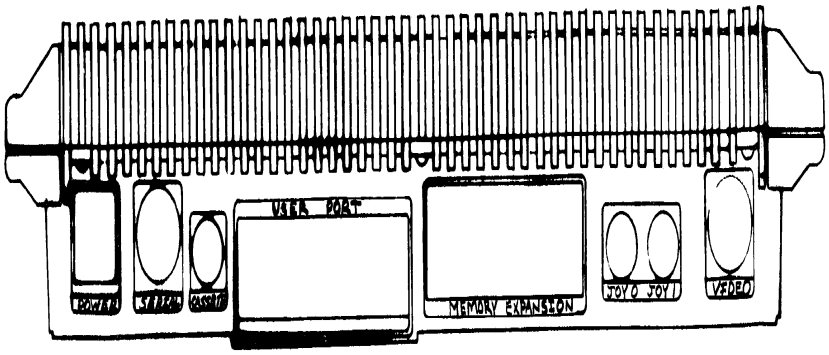
BOTTOM CASE ASSY

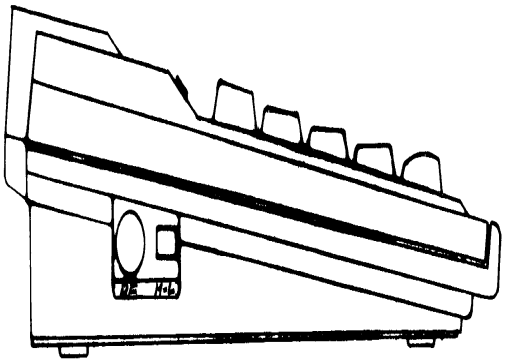
Bottom Case	C 251454-01
Foot, Self-Adhesive	C 950157-04
Paper Shield	C 310156-01
Shield Chip	C 310199-01
Shield Plate	C 310197-01
Insulation Sheet	C 310198-01

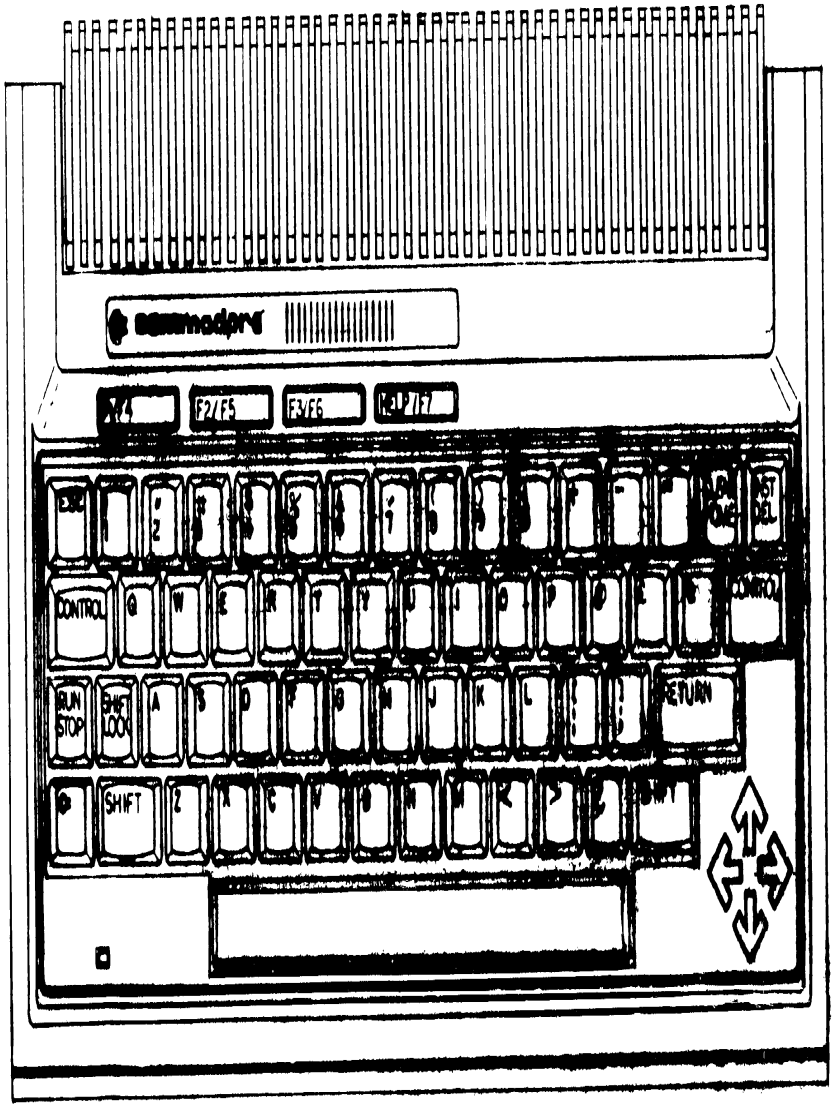
ACCESSORIES

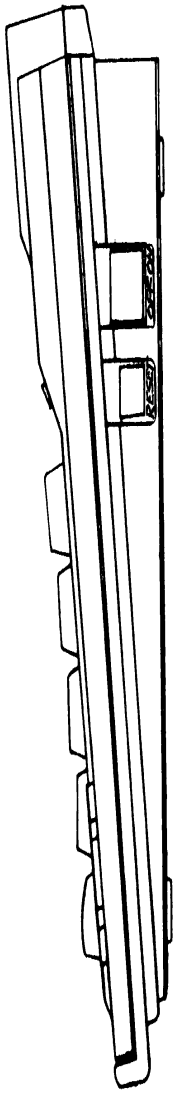
Users Manual	C 310196-01
Power Supply	C 310157
RF Cable	C 326189-02
Switch Box	C 904778-01

C — Commodore Stock Part

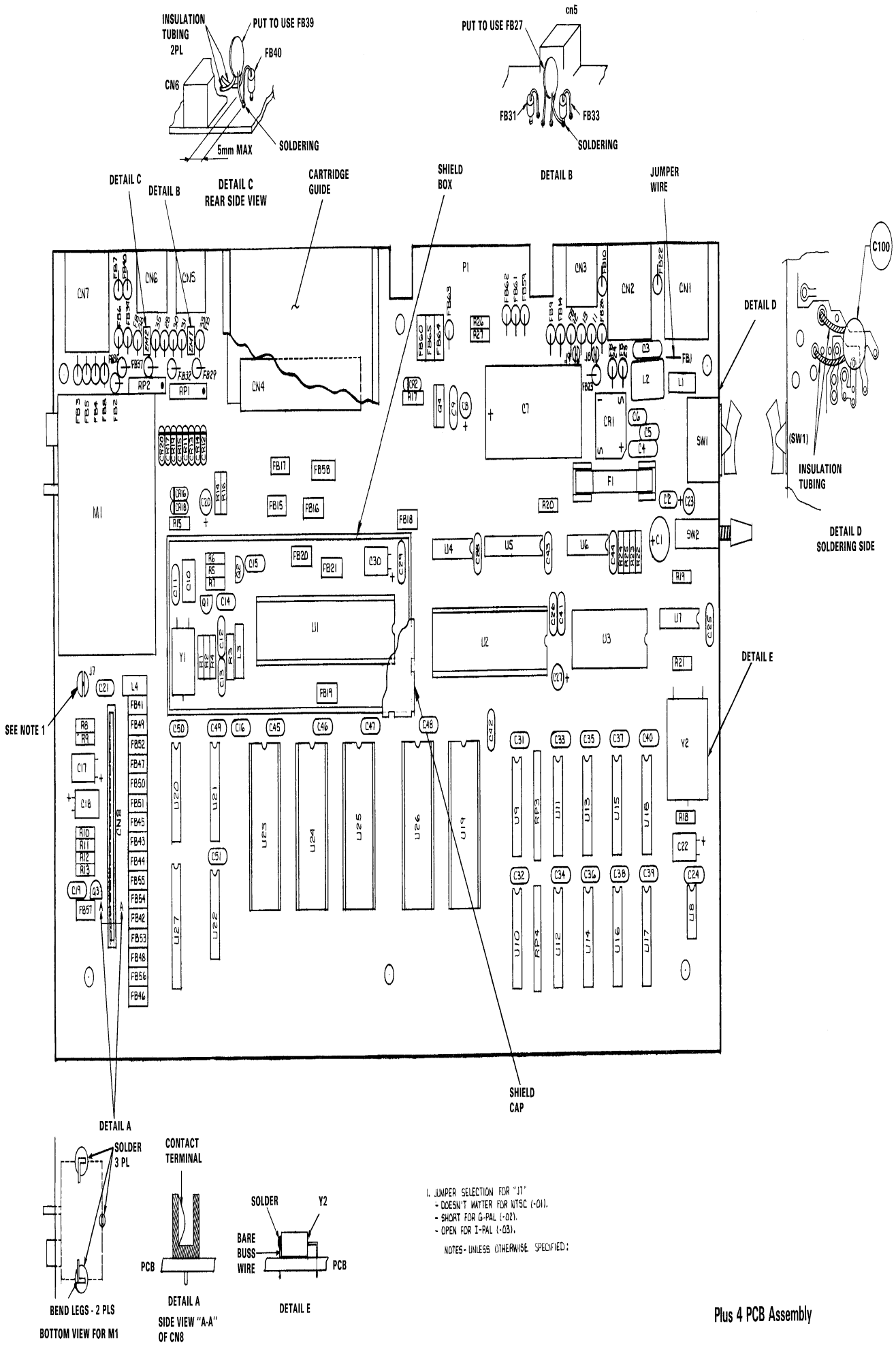








Plus 4 Casework Identification



Plus 4 PCB Assembly

PARTS LIST — PLUS/4 PCB ASSEMBLY #310163-01

PLEASE NOTE: Commodore part numbers are provided for reference only and do not indicate the availability of parts from Commodore. Industry standard parts (Resistors, Capacitors, Connectors) should be secured locally. Approved cross-references for TTL chips, Transistors, etc. will be available in manual form through the Service Department in November of 1984. Unique or non-standard parts will be stocked by Commodore and are indicated on the parts list by a "C".

INTEGRATED CIRCUITS

U1	7360 VLSI, Text Dislay (TED)	
	Sub:	C 251535-01
	8360	C 251535-02
U2	7501 Custom Microprocessor	C 251536-01
U3	6551A (Synertek)	901895-02
U4	74LS08	901521-03
U5	6529B Single Port Interface	C 251640-03
U6	74LS04	901521-02
U7	7406	901522-06
U8	555	901523-01
U9-10	74LS257	901521-57
U11-18	4164-2 D-RAM	901505-01
U19	7700-010 PLA	C 251641-02
U20	74LS139	901521-18
U21	74LS175	901521-34
U22	74LS27	901521-22
U23	2312B ROM TED Basic	C 318006-01
U24	23128 ROM TED Kernal	C 318005-04
U25	23128 FUNCTION ROM, 3+1 LOW	C 317053-01
U26	23128 FUNCTION ROM, 3+HIGH	C 317054-01
U27	6529B Single Port Interface	C 251640-03

TRANSISTORS

Q1-Q3	2SC 1815	902693-01
Q4	2SD 880	902694-01 Sub:
	Tip 29A	902653-01 Sub:
	2SD 1266	902694-04

DIODES

CR1	Bridge Rectifiers S2VB10 Sindengen	215026-01 Sub:
	Bridge Recitifers DBA20B Sanyo	251026-02 Sub:

DIODES (Continued)

CR1	Bridge Rectifiers DBA20C	
(cont.)	Sanyo	251026-03
CR2	Diode, Zener RD 6.8 EB	900927-01
CR11-20	Diode, IN 914 Sub:	900850-16
	Diode, IN 4148 Taping	251819-21 Sub:
	Diode, IN 4148	900850-01

RESISTORS — All values are in ohms-1/4 W 5% unless noted otherwise.

R1	4.7K	R14	240
R2	10K	R15	250
R3	470K	R16	100K
R4	220K	R17	1.5K
R5	18K	R18	47K
R6	1.5K	R19	100K
R7	470K	R20	3K
R8	100K	R21	1K
R9	1K	R22	1K
R10	1K	R23	1K
R11	12K	R24	1K
R12	10K	R25	1K
R13	1K		

RESISTOR PACK

RP1, 2	3.3K, 6 PIN	902441-29
RP3, 4	68, 8 PIN 4 ISOLATED	326149-06

CAPACITORS

C1	Elect	0.1 μF 25V	900100-40
C2	Ceramic	0.1 μF 25V	251075-06
C3	Film	0.22 μF 100V	900150-11
C4	Film	0.22 μF 100V	900150-11
C5-C6	Ceramic	0.22 μF 50V	900022-01
C7	Elect	2200 μF 16V	900101-33
C8	Elect	10 μF 16V	900100-25
C9	Ceramic	0.1 μF 25V	251075-06
C10	Trimmer	40 pF	251029-02
C11	Ceramic	22 pF 50V	251070-14

PARTS LIST – PLUS/4
PCB ASSEMBLY #310163-01 (Continued)

CAPACITORS (Continued)

C12	Ceramic	220 pF 50V	Sub: 251071-26 Sub:
	Ceramic	220 pF 50V	900463-08
C13	Ceramic	150 pF 50V	251071-24 Sub:
	Ceramic	150 pF 50V	900462-41
C14	Ceramic	0.1 μF 25V	251075-01
C15-C16	Ceramic	0.1 μF 25V	251075-06
C17-C18	Ceramic	10 μF 16V	900100-25
C19	Ceramic	0.01 μF 25V	251075-01
C20	Elect	10 μF 16V	900100-25
C21	Ceramic	0.1 μF 25V	251075-06
C22	Elect	10 μF 16V	900100-25
C23	Elect	1 μF 16V	900100-16
C24-C26	Ceramic	0.1 μF 25V	251075-06
C27	Elect	10 μF 16V	900100-25
C28-C29	Ceramic	0.1 μF 25V	251075-06
C30	Elect	10 μF 16V	900100-25
C31-C32	Ceramic	0.1 μF 25V	251075-06
C33-C40	Ceramic	0.22 μF 25V	251075-07 Sub:
	Ceramic	0.22 μF 50V	900022-01
C41-C51	Ceramic	0.1 μF 50V	900020-06 Sub:
	Ceramic	0.1 μF 50V	9000010-01
C100	Ceramic	0.1 μF 50V	900010-20

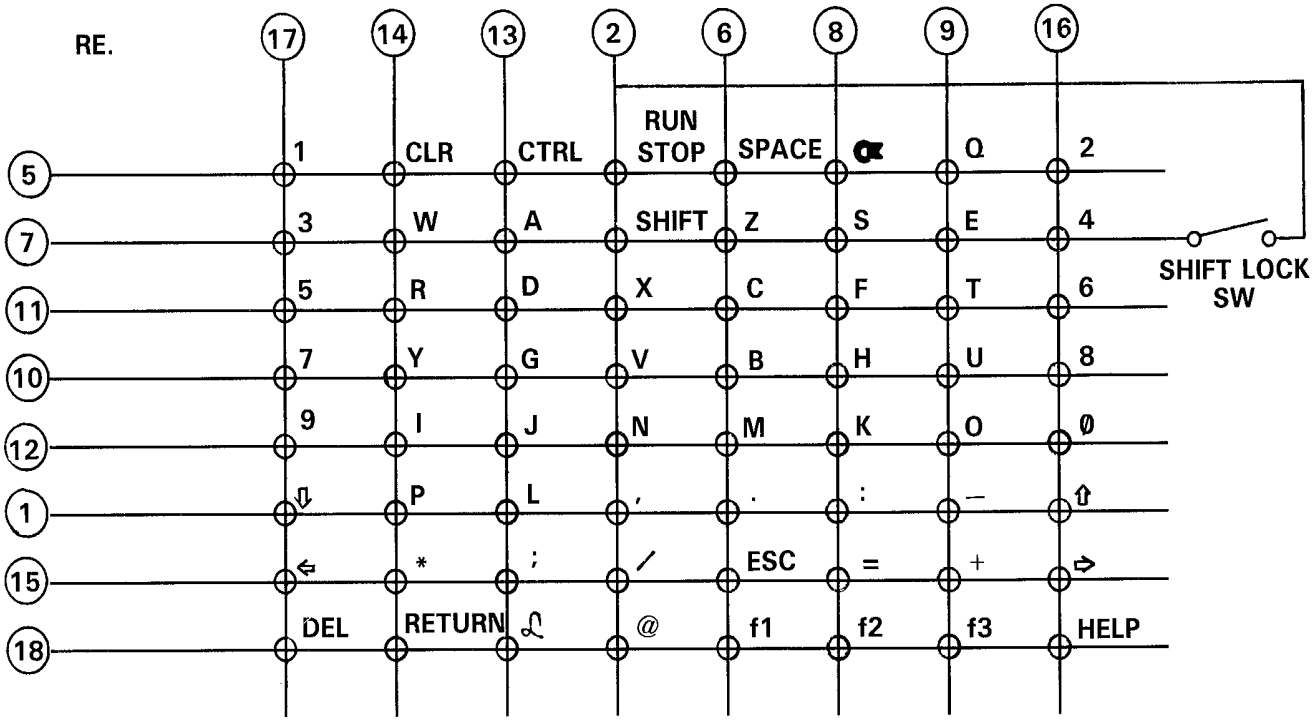
MISCELLANEOUS

Y1	Crystal 14.31818 MHZ	251081-01 Sub:
	Crystal 14.31818 MHZ	251081-02
Y2	Crystal 1.8432 MHZ	900555-02
SW1	Switch, Rocker (PC Mount)	C 251587-01
SW2	Switch, Push Button	C 251260-01
M1	RF Modulator	C 251844-01 Sub:
	RF Modulator	251311-01

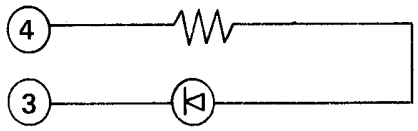
MISCELLANEOUS (Continued)

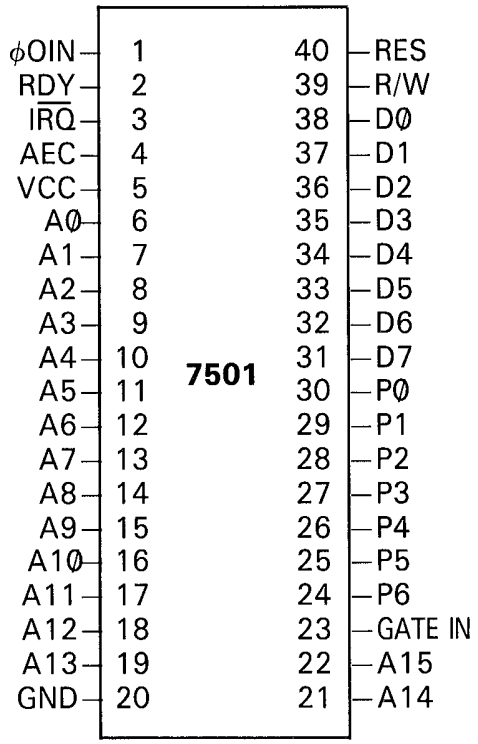
FB2-14	Ferrite bead	325563-01
FB15-21	Ferrite bead	903025-01
FB22-26, FB28-38, FB40	Ferrite bead	325563-01
FB41-58	Ferrite bead	903025-01
FB59	Ferrite bead	325563-01
FB60	Ferrite bead	903025-01
FB61-63	Ferrite bead	325563-01
FB64-65	Ferrite bead	903025-01
EM1,2	EMI Filter	251842-01
CN1	Connector 4 PIN (power supply)	C 251614-01
CN2	Connector 6 PIN DIN (serial bus)	C 903361-01
CN3	Connector 7 PIN MINI DIN (cassette)	C 251616-01
CN4	Connector 50 PIN Female Edge (exoab)	C 251630-01
CN5-6	Connector 8 PIN MINI DIN (joy 1 & 2)	C 251259-01
CN7	Connector 8 PIN DIN (audio/video)	325573-01
CN8	Connector 18 PIN (keyboard)	C 251841-01
L1	Noise Filter	251264-01
L2	Line Filter	906127-01 Sub: 251701-01 Sub:
L3,L3	Coil Inductor 1.2 uHpt	901152-01 Sub: 325570-01
F1	Fuse 250V 1.5A	903556-18
	Fuse Clip	906102-01
	Cartridge Guide	310171-01
	Shield Box	C 310172-01
	Shield Cap	C 310173-01

C – Commodore Stock Part

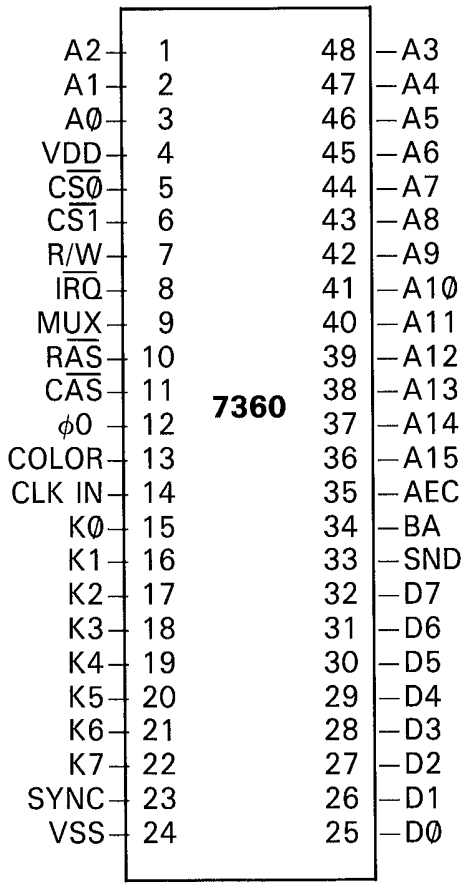


KEYBOARD MATRIX

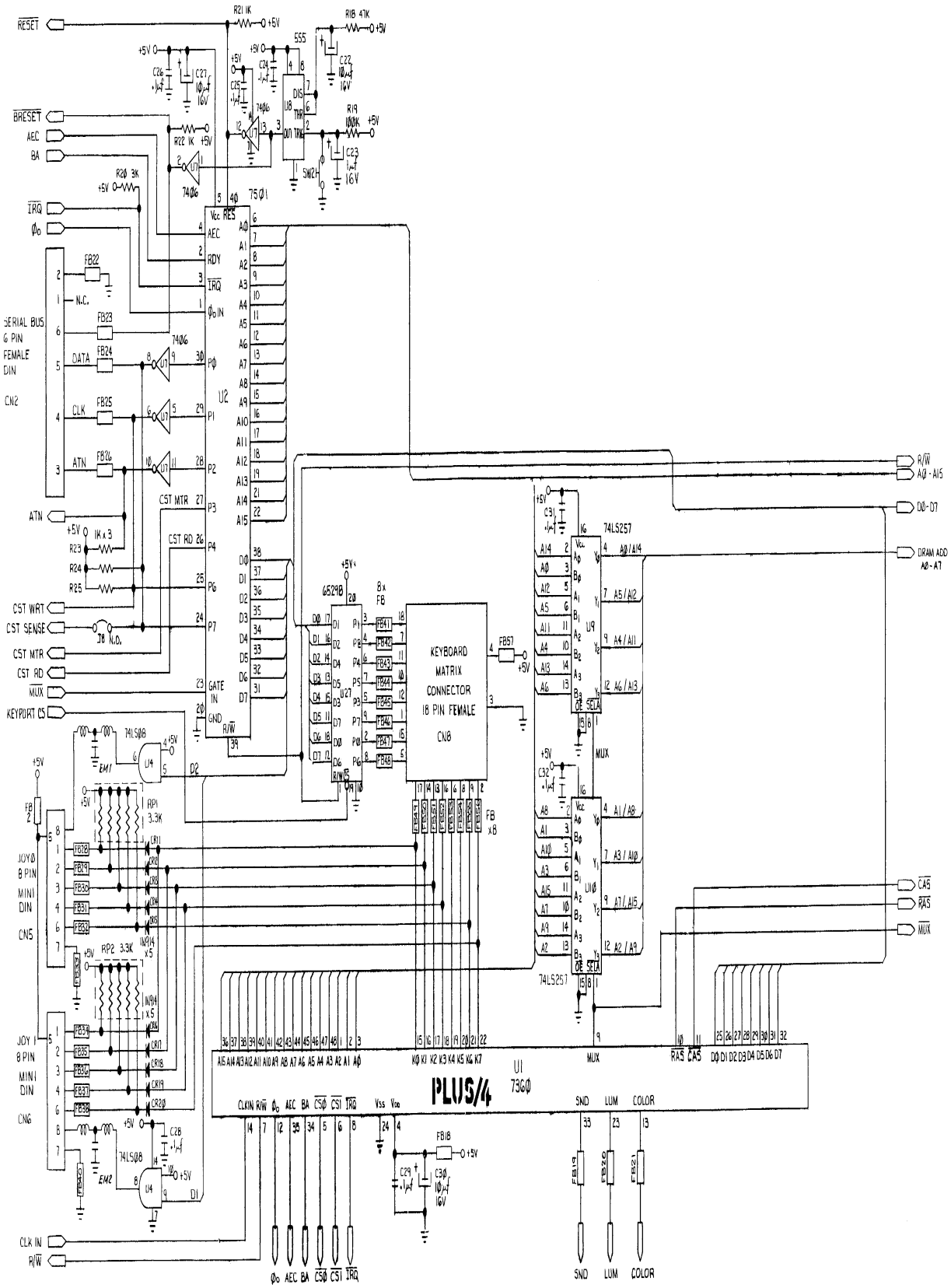




PIN ASSIGNMENT
U2-251536-01
CUSTOM MICROPROCESSOR



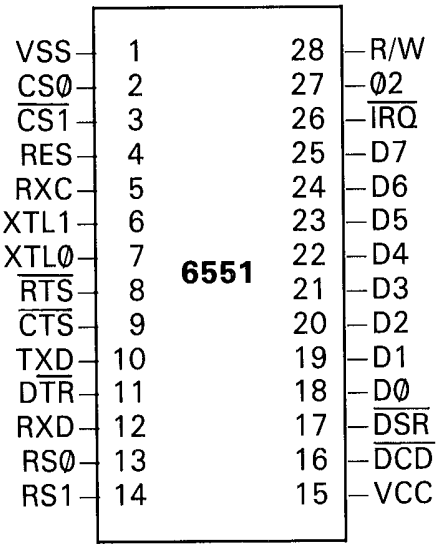
PIN ASSIGNMENT
U1-251535-01
VLSI, TEXT DISPLAY
(TED)



Plus 4 Schematic #310164 (1 of 4)

M_1 SCHEMATIC ON PAGE 11

PIN CONFIGURATION



U3-901895-02
ACIA

SYNERTEK	SYP6551A	2 MHZ

TRANSMIT/RECIEVE CHARACTERISTICS

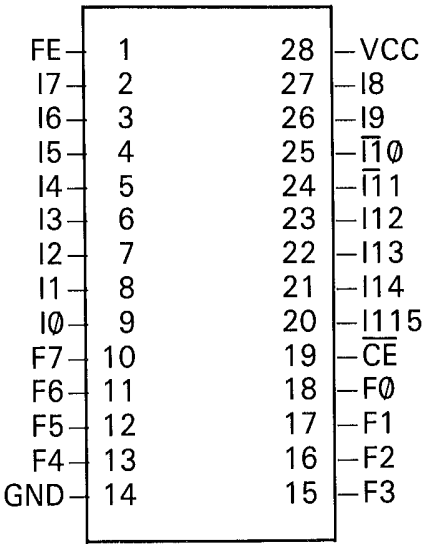
CHARACTERTISTICS	SYM	−02 2 MHZ		UNIT
		MIN	MAX	
TRANSMIT/RECEIVE CLOCK RATE	t_{CCY}	* 400	—	ns
TRANSMIT/RECEIVE CLOCK HIGH TIME	t_{CH}	175	—	ns
TRANSMIT/RECEIVE CLOCK LOW TIME	t_{CL}	175	—	ns
XTL1 TO TXD PROPAGATION DELAY	t_{DD}	—	500	ns
RTS PROPAGATION DELAY	t_{DLY}	—	500	ns
IRQ PROPAGATION DELAY (CLEAR)	t_{IRQ}	—	500	ns

(tr, tf = 10 to 30 ns)

*The Baud Rate with External Clocking is:

$$\text{BAUD RATE} \quad \frac{1}{16 \times T_{CCY}}$$

PIN CONFIGURATION

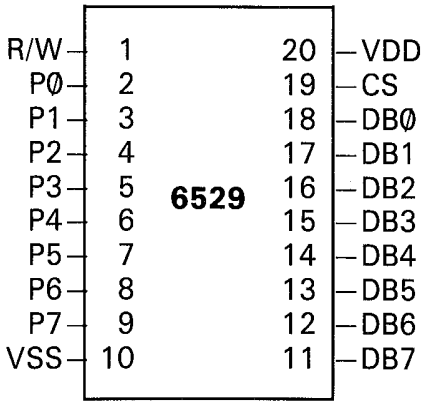


U19-251641-02
PLA

CS	R/W	D0-D7
L	L	DATA BUS TO PORT
L	H	PORT TO DATA BUS
H	X	ISOLATION

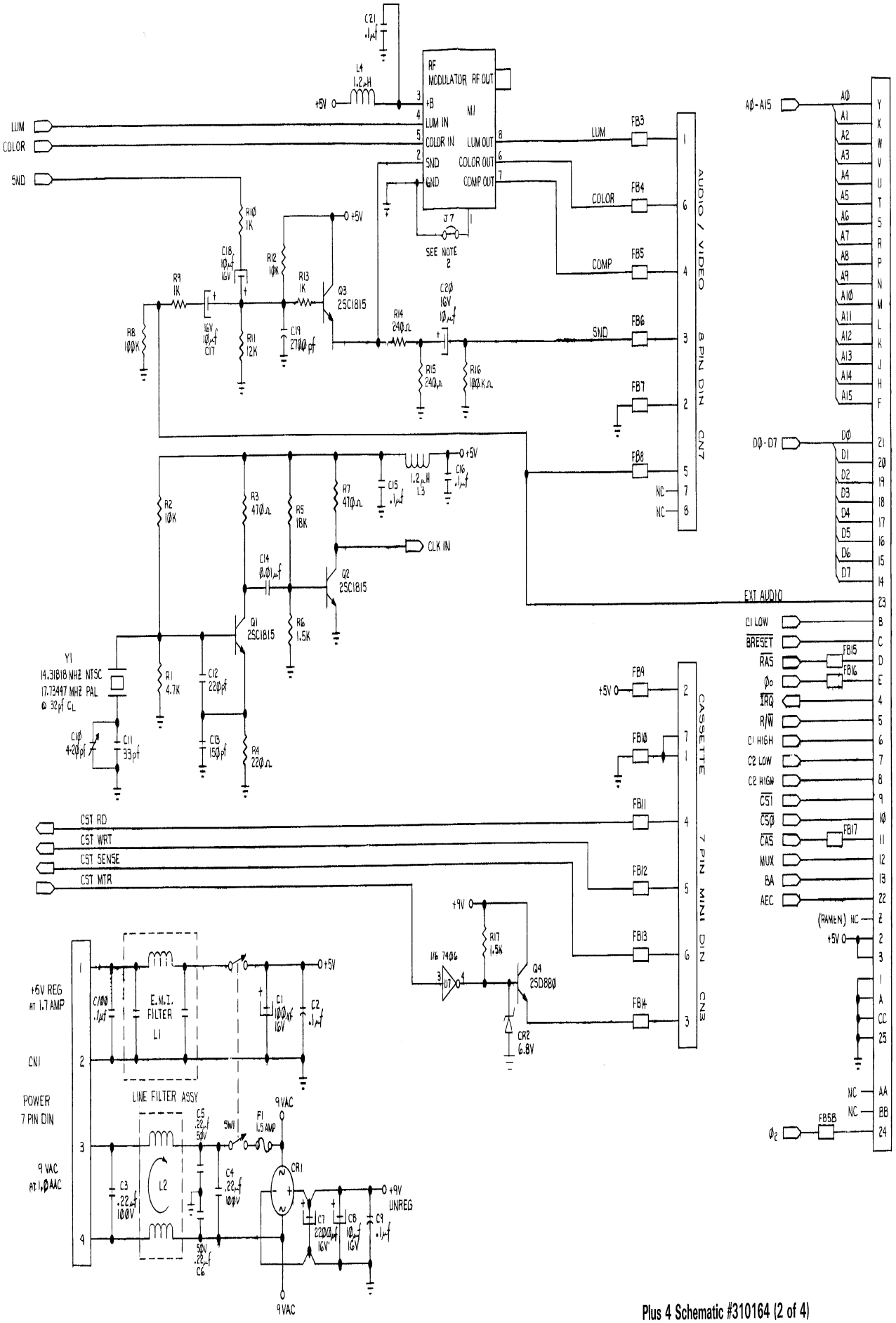
L = LOW LEVEL
H = HIGH LEVEL
X = IRREVELANT

PIN CONFIGURATION



MOS	6529B	3 MHz

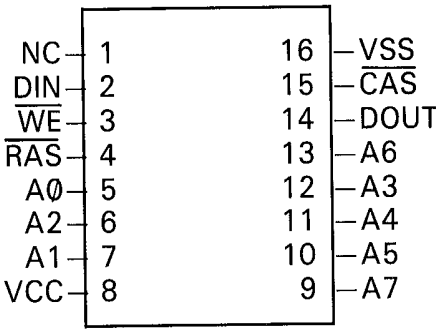
U5/U27-251640-03
SINGLE PORT
INTERFACE



Plus 4 Schematic #310164 (2 of 4)

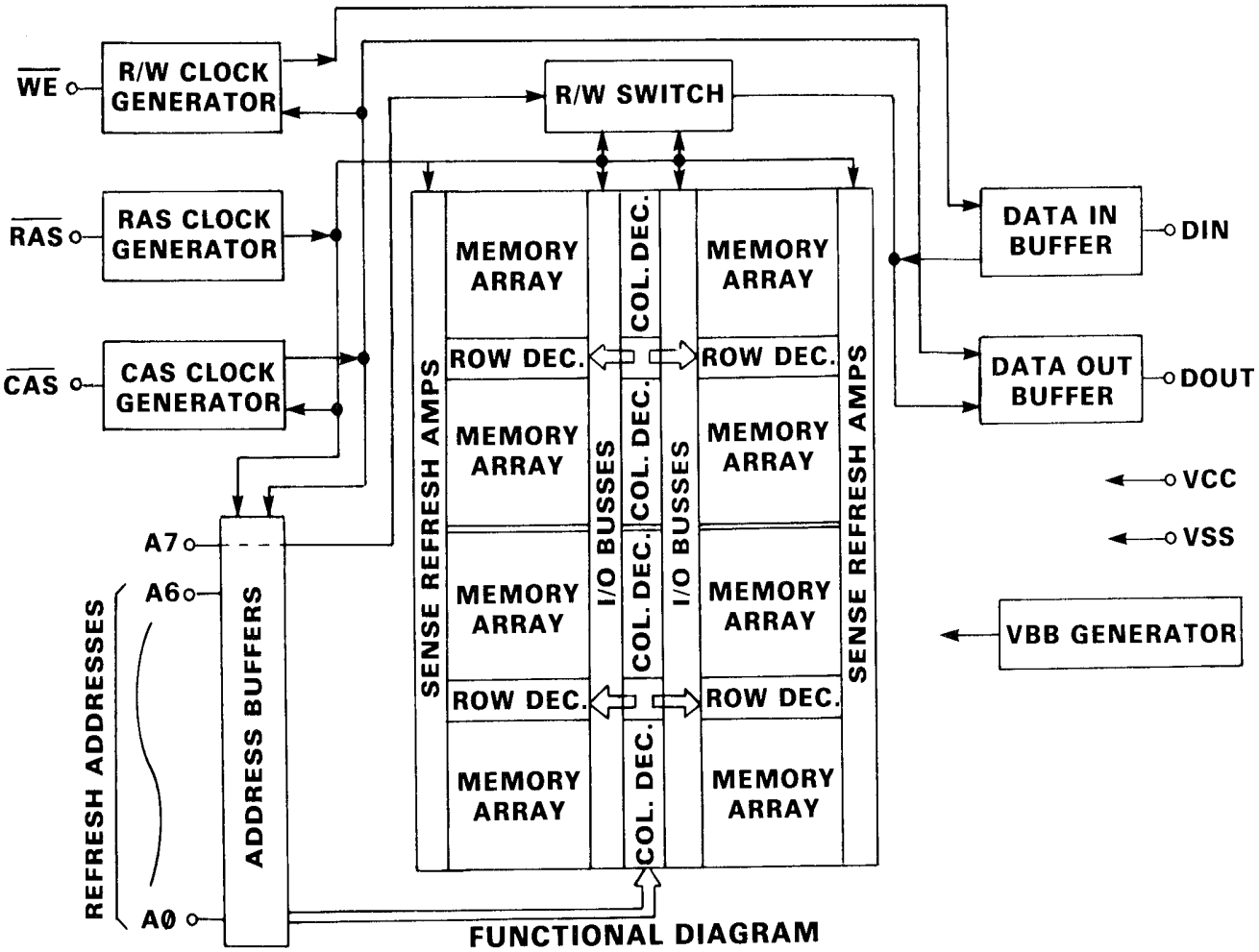
U3, U5, U19 PINOUTS ON PAGE 8

PIN CONFIGURATION

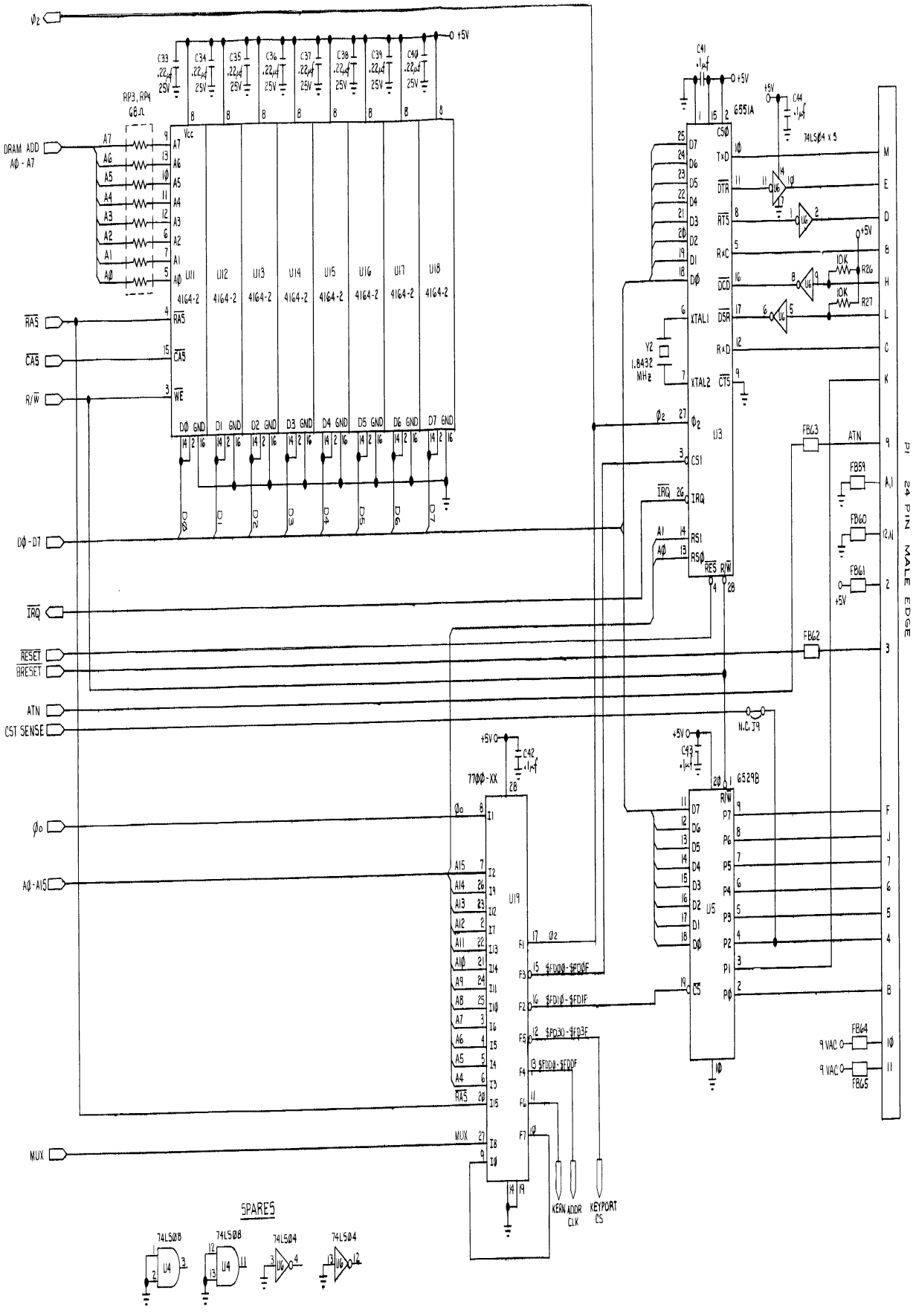


U11 ~ 18
64K DYNAMIC RAM
901505-01

COMMODORE PART NUMBER	APPROVED SOURCE 1 OF SUPPLY	VENDOR PART NUMBER	ACCESS TIME (ns)	CYCLES (ns)	POWER	
					ACTIVE (MW)	STANDBY (MAX)(MW)
901505-01	HITACHI	HM4864-3	200	335	330	20
901505-01	NEC	μPD4164-2	200	375	250	28
901505-01	MITSUBISHI	M5K416NS-20	200	330	275	28
901505-01	MOSTEK	MK4564N-20	200	345	300	22
901505-01	OKI	MSM3764-20	200	330	248	23
901505-01	HITACHI	HM4864P-3	200	335	330	20
901505-01	MATSUSHITA (PANASONIC)	MN4164P-20	200	330	275	27.5
901505-01	SIEMENS	HYB4164-3	200	330	150	20
901505-01	SHARP	LH2164-Z1	200	330	248	28
901505-01	HITACHI	HM4864AP-3	200	330	242	20
901505-01	TOSHIBA	TMM4164AP-20	200	330	275	22

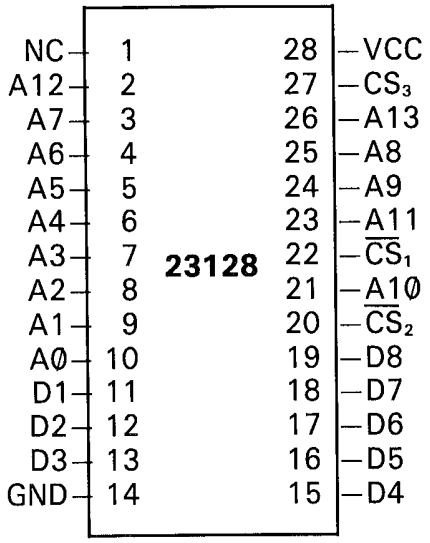


FUNCTIONAL DIAGRAM



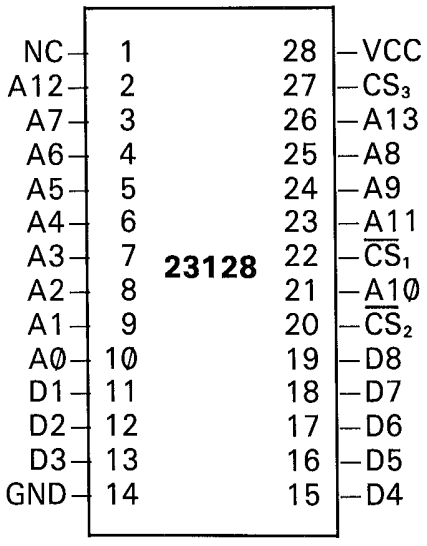
Plus 4 Schematic #310164 (3 of 4)

PIN CONFIGURATION

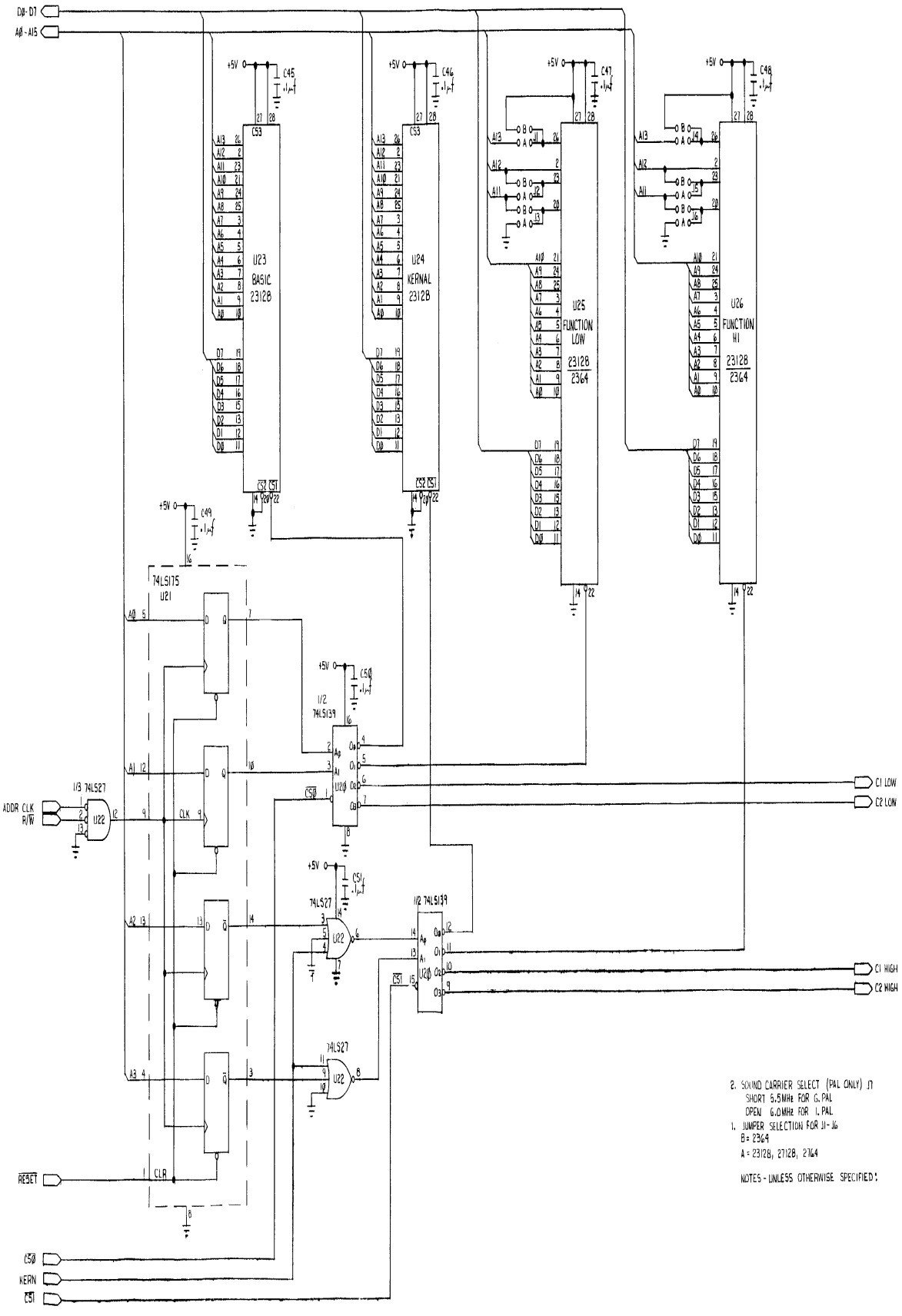


U23-318006-01
ROM – BASIC

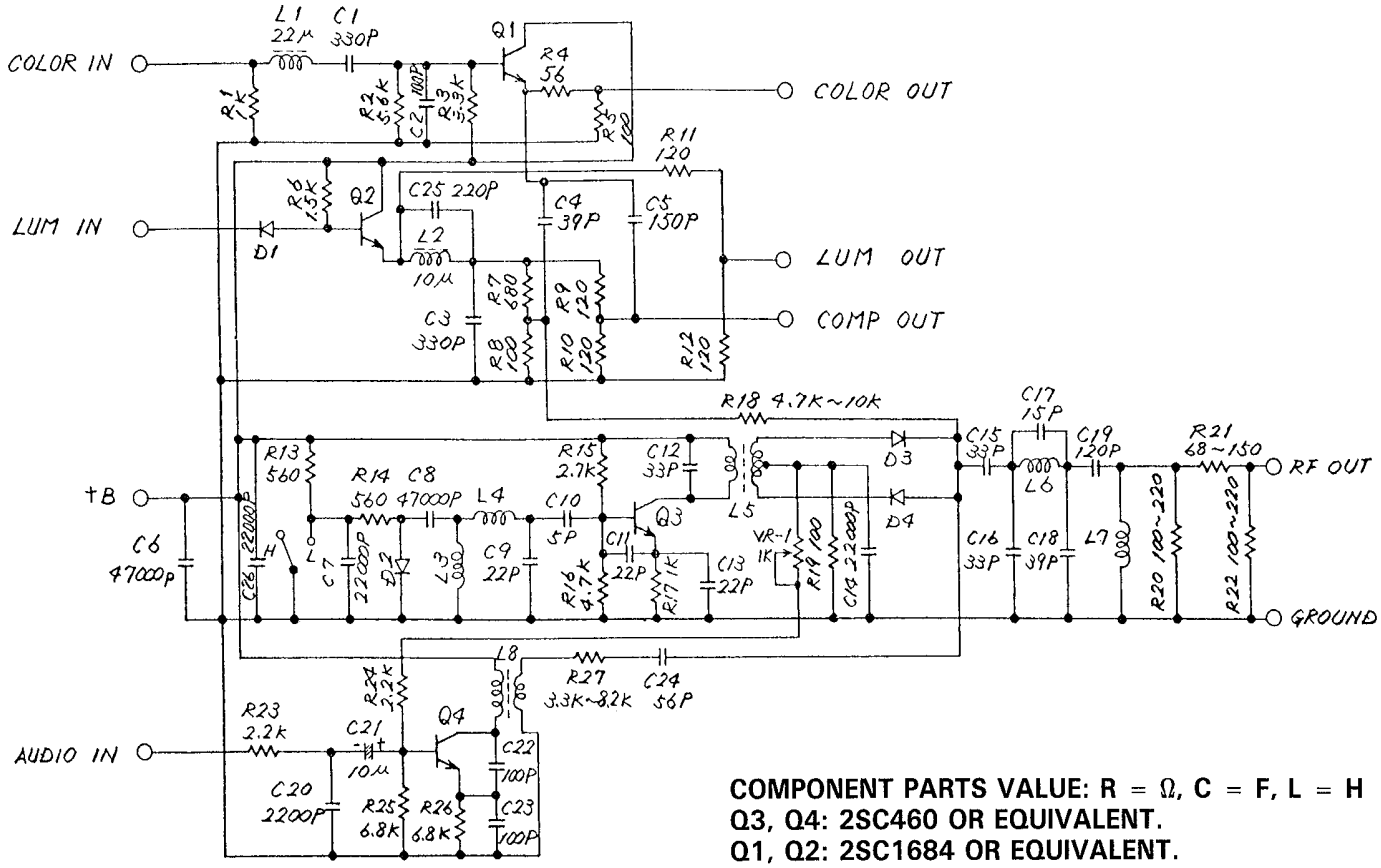
PIN CONFIGURATION



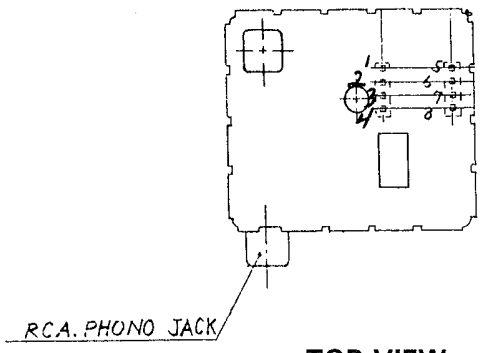
U24-318005-04
ROM – KERNAL



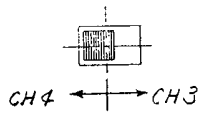
Plus 4 Schematic #310164 (4 of 4)



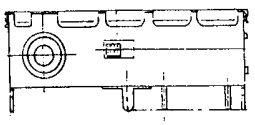
COMPONENT PARTS VALUE: R = Ω, C = F, L = H
Q3, Q4: 2SC460 OR EQUIVALENT.
Q1, Q2: 2SC1684 OR EQUIVALENT.
D3, D4: 1SS198 OR EQUIVALENT.
D2 : 1SS110 OR EQUIVALENT.
D1 : 1SS119 OR EQUIVALENT.



TOP VIEW



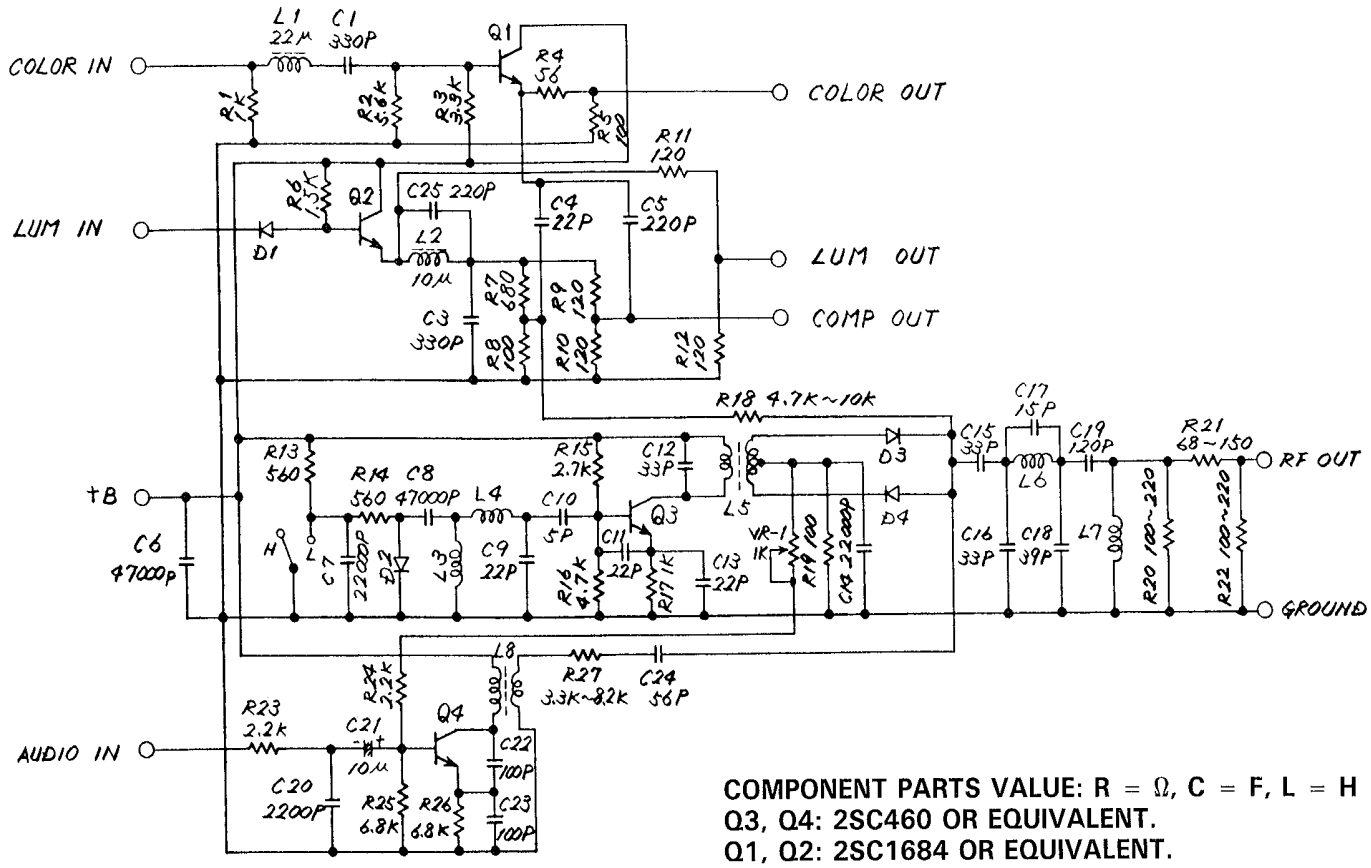
DETAIL (CH. SW)



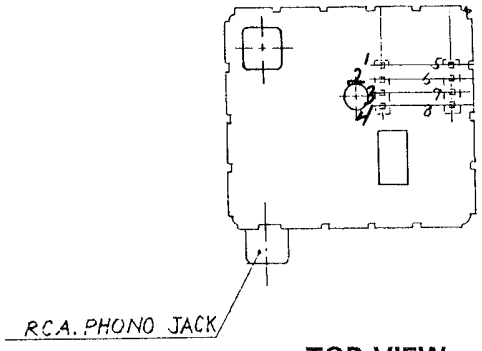
REAR VIEW

NO.	TERMINALS
1	N.C.
2	AUDIO SIG. INPUT
3	+B (+5V)
4	SYNC + LUM. SIG. INPUT
5	COLOR SIG. INPUT
6	COLOR SIG. OUTPUT
7	COMPO. SIG. OUTPUT
8	SYNC + LUM. SIG. OUTPUT
9	RF OUTPUT
10	CHANNEL SELECT SW.

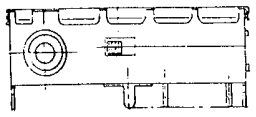
RF Modulator Layout and Schematic #251844



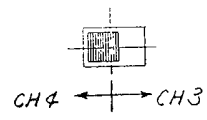
COMPONENT PARTS VALUE: R = Ω, C = F, L = H
Q3, Q4: 2SC460 OR EQUIVALENT.
Q1, Q2: 2SC1684 OR EQUIVALENT.
D3, D4: 1SS198 OR EQUIVALENT.
D2 : 1SS110 OR EQUIVALENT.
D1 : 1SS119 OR EQUIVALENT.



TOP VIEW



REAR VIEW



DETAIL (CH. SW)

NO.	TERMINALS
1	N.C.
2	AUDIO SIG. INPUT
3	+B (+5V)
4	SYNC + LUM. SIG. INPUT
5	COLOR SIG. INPUT
6	COLOR SIG. OUTPUT
7	COMPO. SIG. OUTPUT
8	SYNC + LUM. SIG. OUTPUT
9	RF OUTPUT
10	CHANNEL SELECT SW.

RF Modulator Layout and Schematic #251311

Issue 6, 1984 : Computer 3

commodore TECHTOPICS

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Model: PLUS 4

Troubleshooting Aides

NOTE: Visual inspection is critical in this unit! The upright position of many of the components used on the board can create problems. It is possible for them to be shorted to the shield or to each other. Make sure they are evenly spaced and do not contact the shield.

Areas of the PCB particularly vulnerable to this problem are:

- Bottom right corner - caps
- Bottom center - J1-J6
- Bottom left - Q3 shorted to FB57
- Top left - ferrite beads
- Center - Twisted caps (just outside of RF can)

1) NO VIDEO - Absolutely no video on screen

A) Check for 5 volts
   O.K. ↓
   If not: 1) Check fuse
   2) Check for twisted or bent caps (5 V. short to ground)
   3) Check L1

B) Check for oscillation at pin 14 of U1
   O.K. ↓
   If not: 1) Check for good connection at pin 14 of U1
   2) Check for good connection at R1 thru R7

C) Check for LUM signal at pin 23 of U1, at pin 4 of the modulator, at pin 8 of the modulator, at FB3 and at pin1 of CN7
   O.K. ↓
   If not: 1) Check for LUM signal shorted to ground
   2) Check for open traces
   3) Check modulator

D) Check for reset
   O.K. ↓

E) Check for control signals:

Signal	I.C.	Pin	Signal	I.C.	Pin
AEC	U1	35	R/W	U1	7
AEC	U2	4	0	U1	12
CAS	U1	11	MUX	U1	9
CS1	U1	6	IRQ	U1	8
CS1	U20	15	RDY	U2	2
CS0	U1	5	BA	U1	34
CS0	U20	1	RAS	U1	10

2) BAD VIDEO - Scrolling lines on screen - Random blocks on screen - Blurred display

A) Check J1-J6 for shorts to ground or each other
O.K.
↓
B) Check reset for correct operation
O.K.
↓
C) Check U1 for proper operation
O.K. If not: 1) Check socket for good solder
↓ 2) Check for bad U1
D) Check U2 for proper operation
O.K. If not: 1) Check socket
↓ 2) Check for bad U2
E) Check RAM data lines for correct amplitude
O.K. If not: 1) Check for hot surface of RAM
↓ 2) Jump out RAM to verify
F) Check multiplexers U9, U10 - signals at RP3 and RP4 should be similar in frequency and amplitude
O.K. If not: 1) Suspect U9 or U10
↓
G) Check ROM for chip select signal at pin 22 of U23 and U24
O.K. If not: 1) Check for signal generation
↓ at U20
H) Check that all ROM addresses are present and correct amplitude
O.K. If not: 1) Trace problem address A0-A15
↓
I) Check U19, U23, U24 by replacement with known good

3) NO POWER

A) Verify voltage +5 and +9 volts
1) Check for shorts to ground
2) Check switch
3) Check power supply

4) BAD BASIC - Random characters on screen - Random colors - Power-up message is missing

A) Check Basic ROM U23
B) Check B thru I above (Bad Video)

5) NO COLOR or BAD COLOR

A) Check U1 pin 14 for 14.31818 MHz with frequency counter
O.K. ↓ If not: 1) Check solder joints of CT1 and adjust for correct frequency
2) Check crystal, Q1 and Q2
3) Check clock circuit for opens or shorts

B) Check U1 pin 13 for Color Out signal.
O.K. ↓ If not: 1) Swap U1 w/known good

C) Check modulator M1 pin 5 for Color In signal and pin 6 for Color Out signal
O.K. ↓ If not: 1) Check M1 operation

D) Check FB4 and CN7 pin 6 to see if color signal is present.
1) Check for shorts

6) NO SOUND or BAD SOUND

A) Check U1 pin 33 for SND signal
O.K. ↓ If not: 1) Check socket for open circuit
2) Swap U1 w/known good

B) Check audio circuit for short to ground or loss of signal.
O.K. ↓ If not: 1) Check Q3 - Be sure emitter and base are not shorted to 5 V.

C) Check modulator M1 pin 2 for SND signal
1) Adjust I.F. can (top right of modulator) for clean, loud volume
2) M1 pin 2 to ground should read approximately 480 ohms
3) Check M1 for component failure

7) SERIAL FAILURES

A) Check FB23-26 for shorts to shield or each other
B) Check U7, U2 and CN2

8) KEYBOARD FAILURES

A) Check pins on ribbon cable for good connection
O.K.
↓
B) Check for shorts - CN5, CN6, FB's, Diodes
O.K.
↓
C) Check chip select to U27 and the I.C. U27
O.K.
↓
D) Check U1 for proper operation
O.K. If not: 1) Check socket
↓ 2) Check for bad U1

9) FAILURES IN SOFTWARE MODE - All units should be checked for proper operation, when any repairs are necessary.
To Check: 1) Press 'F1' on keyboard
2) Press 'Return' to enter Word Processing mode
3) Press 'Commodore' key and 'C' key at the same time
4) Type 'tc' and press 'Return' to enter Spreadsheet
5) Press 'Commodore' key and 'C' key again
6) Type 'tw' to return to Word Processing mode

Watch for video or loading problems, then:

A) Check jumpers at J1-J6 for correct connection
O.K.
↓
B) Check U1, U2, U25, U26

Issue 7, 1984 : Computer 4

commodore TECHTOPICS

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Model: C16, PLUS 4

LINE DEFINITIONS

A0 to A15	Address Bit 0 to 15
AEC	Address Enable Control
ATN	Attention
BA	Bus Available
BRESET	Buffered System Reset
C1 HIGH, C1 LOW	External Cartridge Chip Select
C2 HIGH, C2 LOW	"
CAS	Dynamic RAM Column Address Strobe
CLK IN	Master Clock (Single Phase, 14.31818 MHz)
COLOR	Chroma Output
COMP	Composite Chroma and Luma
CE	Chip Enable
CS	Chip Select
CS0	Low ROM Chip Select
CS1	High ROM Chip Select
CST MTR	Cassette Motor Control
CST RD	Cassette Read
CST SENSE	Cassette Sensor
CST WRT	Cassette Write
CTS	Clear To Send
DB0 to DB7	Data Bit 0 to 7
DCD	Data Carrier Detect
DRAM	Dynamic RAM
DRAM ADD	Dynamic RAM Address
DSR	Data Set Ready
DTR	Data Terminal Ready
EXT AUDIO	External Audio Input
GATE IN	R/W GATE
IRQ	Interupt Request
K0 to K7	Keyboard Latch 0 to 7
KERN	Kernal ROM Control Line
LUM	Composite Sync and Luminence
MUX	Address Multiplex Control
P0 to P7	Port Bit 0 to 7
RAS	Dynamic RAM Row Address Strobe
RESET	System Reset
RxC	Receive Clock
RxD	Receive Data
R/W	Read/Write Line
RTS	Request To Send
SND	Sound Line
TED	Text Display
TxD	Transmit Data
ϕ 0	System Clock (Varies between 1 and 2 MHz)
ϕ 2	Artificial ϕ 2, Address Valid Rising Edge, Data Valid Falling Edge

Issue 6, 1985 : Computer 1

Model: C-64, C-16, Plus 4

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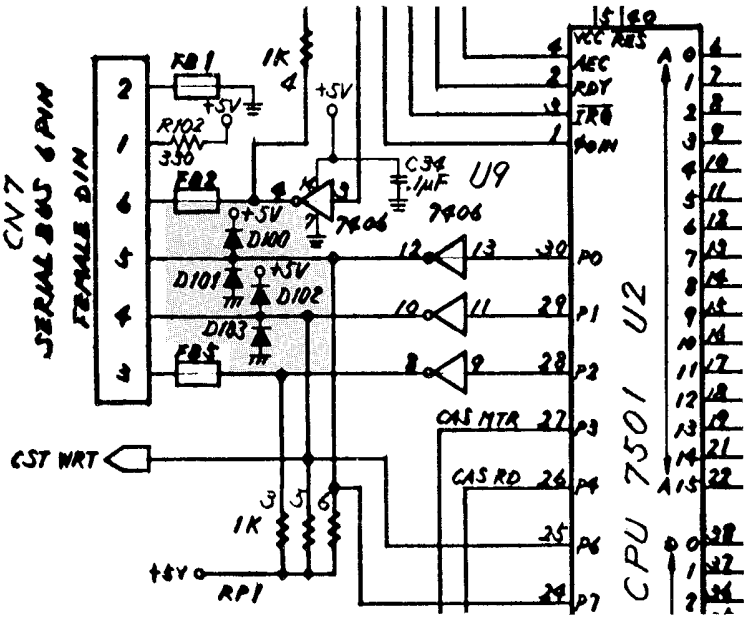
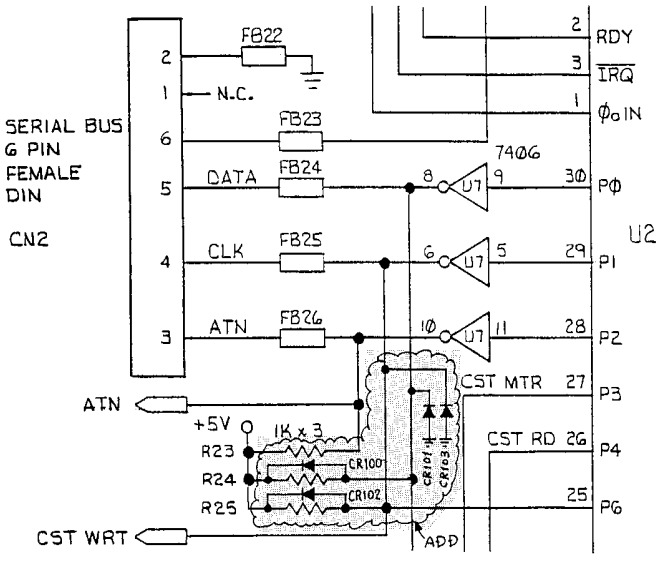
SCHEMATICS FOR C-64, C-16, PLUS 4

These computers have been affected by an Engineering Change Order that adds 4 diodes to the serial port. These protection diodes are not required as field upgrades. They are 1N914s and were added as a circuit improvement.

The Schematic and PCB Layout for the C-64 in the Service Manual (Pages 28 and 32) include these diodes. However, the C-16 and Plus 4 Service Manuals were completed before the changes were made. The Schematic corrections are shown below:



C-16 SCHEMATIC



PLUS 4 SCHEMATIC